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Praestorrsella roestae (Visser), a foraminiferal index fossil for Late Cretaceous deeper neritic deposits

By

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With 2 Text-Figures and 2 Plates

ABSTRACT

The genus *Praestorrsella* Gowda, 1978 (with its type species *Cibicides roestae* Visser, 1951) is transferred from the Rotaliidae to the Glabratellidae taking into account its tightly coiled trochospiral test of small size with conspicuous dorsal ornamentation by pustules, its ventral radial grooves indicating plastogamic reproduction, the closely grouped umbilical piles and some common features of internal architecture of the shell, in particular the presence of a low umbilical plate with a large radial passage from chamber lumen to umbilical cavity. *P. roestae* produces structurally complex intersections easy to recognize in random thin slides of Late Cretaceous deeper neritic deposits rich in orbitoid foraminifera.

ZUSAMMENFASSUNG

Das Genus *Praestorrsella* Gowda, 1978 (Typspecies *Cibicides roestae* Visser, 1951) wird von der Familie Rotaliidae zu den Glabratellidae transferiert auf Grund von den engtrochospiralen, auffallend kleinwüchsigen Schalen mit einer starken Ornamentierung der Dorsalseite durch engstehende Pusteln, von radialen Rillen auf der ventralen Schalenseite, welche auf plastogame Vermehrung hinweisen, und von den eng gruppierten Umbilicalpfeilern. Außerdem gibt es deutliche Gemeinsamkeiten im architektonischen Aufbau der Schale, insbesondere eine niedrige Umbilicalplatte mit einem radialen Durchgang, welcher das Kammerlumen mit den Hohlräumen der Umbilicalregion verbindet. Im nicht-orientierten Dünnschliff produzieren die kleinen Schalen komplexe, aber leicht zu erkennende Schnittfiguren in Gestein, welches die tieferneritischen Ablagerungen reich an orbitoiden Foraminiferen des Campan und des Maastricht charakterisiert.

1. INTRODUCTION

In random thin sections of orbitoidal limestones, very small but structurally complex sections of a tightly coiled rotaliid foraminifer often occur. They characterize deeper neritic deposits of Late Campanian and Maestrichtian age in association with *Sirtina* sp., *Lepidorbitoides* sp., *Hellenocyclina* sp. and/or small, compressed siderolitids. These sections are identified here as belonging to shells of *Cibicides roestae* Visser, type species of the genus *Praestorrsella* Gowda as picked up by Loeblich & Tappan 1987. As it happens, Gowda had worked out his thesis at the University of Basel and had left some of his material from India in the collections of this institution. We are therefore in a position to compare topotype material of *Cibicides roestae* Visser from Maestricht with Gowda's material from India and with the random sections in hard rock from many places in Spain or from elsewhere.

P. roestae is a striking example for many benthic species easy to identify by their complex, peculiar structure but difficult to classify by the lack of adequate structural analysis. In the case of *P. roestae*, this difficulty is reflected by its frequently changing attribution to different genera in subsequent publications. With the proposition of a particular generic name for this species by Gowda, its nomenclature may be stabilized but the problem as to its systematic position is not solved.

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Praestorrsella roestae was discovered in 1951 by VISSER in the type Maestrichtian deposits and described under the generic name *Cibicides*. It was classified later by HOFKER in 1955 as *Lockhartia* and subsequently (HOFKER 1966) as *Tremastegina* and thus transferred from the rotaliids to the amphisteginids. GOWDA (1978) retransferred the species to the rotaliids; its particular generic name expresses its supposed closeness to the Paleocene genus *Storrsella*. LOEBLICH & TAPPAN (1987) followed this opinion stressing however the need of more detailed and more objective morphological documentation. The latter consists so far mainly of HOFKER's drawings in several subsequent publications. They provide contradicting evidence clearly biased by successive, fundamentally different interpretations.

Thus, the purpose of this paper is to provide additional documentation of the external and internal morphology of *P. roestae*'s shell, to analyze its structural features and to discuss its systematic position.

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2. SYSTEMATIC DESCRIPTION

Praestorrsella roestae (VISSER, 1951)
Pl. 1, Fig. 1-19; Pl. 2, Fig. 1-9; Text-Fig. 1

1951 *Cibicides roestae* n. sp. - VISSER: 291, pl. 6, fig. 9.
1955 *Lockhartia roestae* (VISSER). - HOFKER: 4-5, fig. a-e.
1959 *Lockhartia roestae* (VISSER). - HOFKER: 289-290, figs. 95-96.
1966 *Tremastegina roestae* (VISSER). - HOFKER: 24, figs. 1-9.
1964 b *Rotalia* (s. l.) *roestae* (VISSER). - GOWDA: 308.
1977 *Tremastegina roestae* (VISSER). - VILLAIN: 67.
1978 *Praestorrsella roestae* (VISSER). - GOWDA: 3, fig. 2 a-k, fig. 3 a, b.
1985 *Tremastegina roestae* (VISSER). - DROOGER & DE KLERK: 120, pl. 1, fig. 1.
1987 *Praestorrsella roestae* (VISSER). - LOEBLICH & TAPPAN: 662, pl. 758, fig. 7-11.

2.1 EXTERNAL ASPECT OF SHELL

Comparatively small (about 0,5 mm in diameter) lamellar-perforate, trochospiral, involute, inequally biconvex, subconical to hemispherical test.

Dorsal side hemispherical to conical, strongly ornate with imperforate, thick pustules arranged in vaguely spiral pattern; dorsal chamber sutures in few ultimate chambers backwards inclined, depressed or flush, in earlier chambers obscured by ornamentation, visible only when the lateral chamber wall of the last few chambers is eroded. The alar chamber-extensions form loose spirals reaching the shell apex in about half a volution. Dorsal lateral chamber walls coarsely perforate inbetween imperforate, heavy pustules reaching the height of the chamber lumen in the subsequent shell whorl.

Ventral shell surface convex but flattened, always much less convex than dorsal side. Septal sutures obscured by heavy ornamentation covering the ventral, lateral chamber walls with radially directed, simple or outwardly forked, imperforate ridges alternating with narrow radial grooves carpeted with two or three rows of pore mouths. Towards the umbilical region, the grooves fuse into a reticular pattern similar to the pattern of reticular zones in orbitolinids (but of course not homologous with such a structure).

Periphery rounded to angular, ornamented by the peripheral end of the ventral imperforate ridges. In the ultimate half or quarter whorl, the periphery may be faintly lobulate. 12 chambers in the last whorl of adult specimens reaching about 0,5 mm in diameter. Aperture not observed.

2.2 ARCHITECTURE
(Text-Fig. 1)

The growth spiral of this species is very tightly coiled: in the equatorial zone, the radial extension of the chamber lumen is not much more than twice the chamber height in the dorsal and less than twice the height of the ventral alar chamber extensions. Dorsal part of the septum straight, inclined backwards with respect to the direction of growth. Dorsal alar extension of the septum very low, reaching the apex in a loose coil of half a volution.

The shell has a narrow umbilical space filled with a group of umbilical piles protruding more or less from the ventral surface of the shell. In the umbilical area, this surface is formed by fused triangular folia. The foliar nature of the umbilical cover can be recognized only in sections of the shell as the ornamentation obscures the sutures of subsequent folia. Residual foliar apertures are kept open during growth of subsequent whorls and produce vertical canals opening into the ambient environment inbetween umbilical piles.

Intercameral foramen consisting of a single, low arch in marginal-interiomarginal position at the base of the septal face.

There is a septal flap covering only small parts of the septal face in the ventral part of the shell. No septal flap was observed on the dorsal part of the septum. The septal flap merges into a tiny umbilical plate separating the ventral main chamber lumen from an umbilical cavity system. The umbilical plate admits a single, large, rounded passage connecting the ventral chamber lumen in radial direction with the umbilical cavities.

The strong ornamentation of the previous whorl by inflational pustules combined with the exceptionally low chamber cavities produce partial subdivisions of the chamber lumen. On the ventral side, the radial ridges on the previous whorl occupy about half of the ventral chamber lumen in the next whorl. Their peripheral extensions however touch the

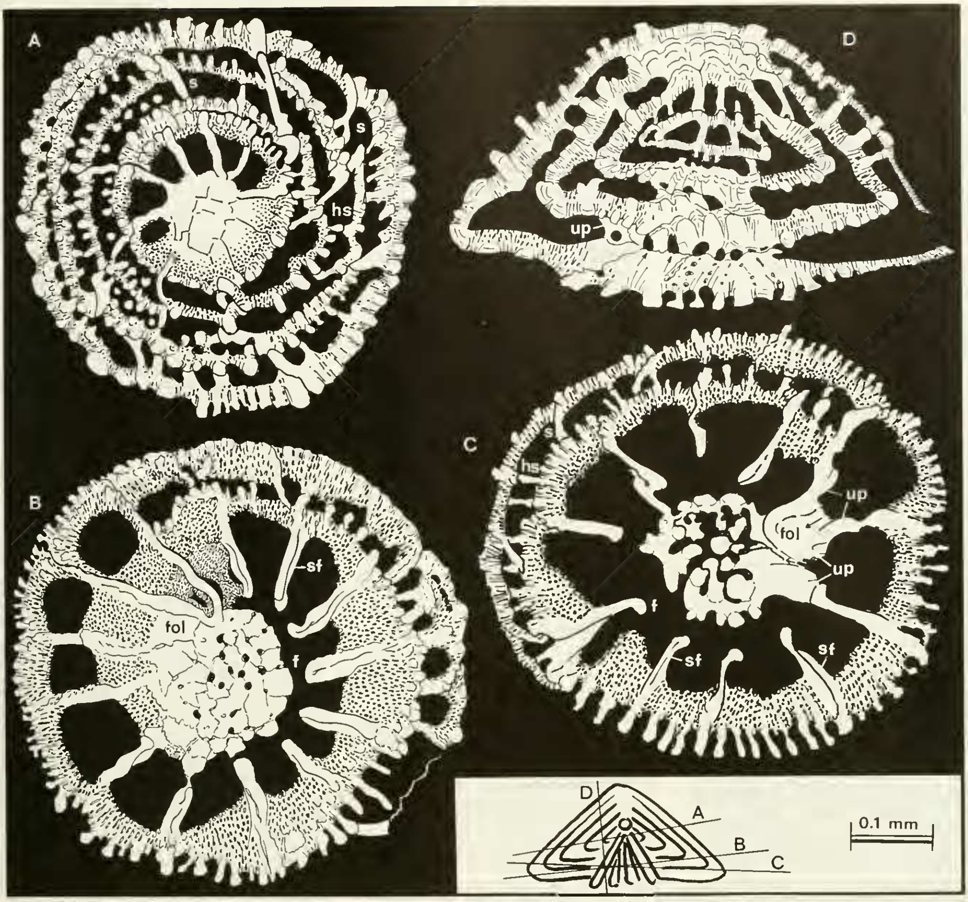


Fig. 1 A-D: *Praestorrsella roestae* (VISSER). - Camera lucida drawings. Position of sections see A-D in legend. f: foramen, fol: folium, hs: hemiseptulum, s: septum, sf: septal flap, up: umbilical plate producing in section C „shoulders" between which the radial passage (arrow) admits communication between main chamber lumen and umbilical cavities. A from Vilavella fm., Pyrenees; Campanian. B-C from Southern India; Maastrichtian.

very low ventral lateral walls and fuse with its inner lining producing thus hemiseptula with a circular to oval cross-section. The previous whorl's pustules on the dorsal side touch the low lateral walls and subdivide the dorsal alar extensions of the chamber cavity with cylindrical hemiseptular elements. In contrast to the umbilical zone, the dorsal pustules are intermittently superposed from one whorl to the next producing only few, radial piles of lamellae. The disposition of the umbilical pustules is strongly coordinated from one whorl to the next by superposition. The latter produces a regular, conical bundle of piles from the first to the last whorl. In-between the piles of lamellae, vertical umbilical canals connect the cavities of superposed shell whorls. They are inter-connected by an horizontal network of canals derived from covering the reticular grooves on the ventral shell surface by the next whorl.

Proloculus spherical, about 30 µm wide. No dimorphism observed.

2.3 DISTRIBUTION

P. roestae is known so far from Maastricht (Netherlands, type locality of the Maestrichtian stage), the Pyrenean Basin and its margins south and north of today's mountain range, from the Subbetic margin of the Betic Cordillieran Basin in Southern Spain (Sierra Seca, Granada; AZEMA et al. 1979: pl. XL), and from Southern India (see in particular the list of synonymies). In all those cases, *P. roestae* is associated to orbitoid foraminifera indicating a Maestrichtian and possibly also Campanian age. For more precision, a revision of the Campanian-Maestrichtian boundary and its position in respect of orbitoid evolution would be necessary.

2.4 OTHER SPECIES

GOWDA (1978) described additional two species as belonging to his new genus *Praestorrsella*. The material available in Basel does not allow to recognize the two species. From the somewhat summary description given by GOWDA, it seems very probable that these two species are not to be placed in the genus *Praestorrsella: P. reicheli* GOWDA may be a *Daviesina* or a small *Siderolites*, while *P. ariyalurensis*, described as evolute on the ventral side, is not recognizable beyond this feature. Thus, for the time being, *Praestorrsella* has to be considered as a monotypic genus.

3. DISCUSSION

P. roestae has a very small size. Therefore, primary cements coating the cavities and/or outer shell surfaces hamper the analysis of the structural elements more than in larger-sized isolated specimens and may obscure pores and passages. By combining the observations on random sections in hard rock, on oriented sections of isolated specimens and on SEM graphs, we try to document the structural features of this form in spite of its small size. However, the preservation of the material does not permit a close analysis of the lamellar architecture.

VISSER's description from 1951 concerns only the outward aspect of shell morphology in this species. HOFKER's interpretation of its structure was based on sections of isolated topotypes from Maastricht coated by primary cements illustrated by camera lucida drawings. They agree with our own observations as to chamber arrangement, as to the position of the marginal-interiomarginal foramen and as to the existence of dorsal hemiseptula generated by pustules supporting the lateral walls of the next whorl's chamber. They also agree to some extent with the existence of a tiny circum-umbilical cavity producing a kind of spiral canal by the separation of the main chamber lumen from the umbilical cavity system by an umbilical plate.

This latter element was singled out in HOFKER's drawings 4, 7, 8 (1966) by stippled surfaces interpreted as tooth-plates. However, our material has not produced intersections as HOFKER's fig. 8 (1966) comparable to *Pararotalia* and *Neorotalia* with a free edge of a true toothplate and corresponding to an areal, komma-shaped foramen (HOTTINGER et al. 1991). Therefore, we interpret this element as umbilical plate.

HOFKER's fig. 9 (1966) depicts stellar chamberlets on the highly convex side of the shell as revealed by chemical erosion of the shell surface. For this reason, he interpreted the highly convex side of the shell as ventral and accordingly the coiling as inverse-trochospiral. This is in opposition to HOFKER's own oblique and equatorial sections (1966, fig. 4, 6) and to our own observations. There is a simple spiral of uniserial chambers in this species. Therefore, *P. roestae* has no relations with amphistiginids.

Neither the original manuscript thesis of GOWDA (1964a) nor its partial publication (GOWDA 1978) produce in its drawings supplementary information on *P. roestae*'s structure. According to GOWDA's verbal description, LOEBLICH & TAPPAN (1987) define the genus *Praestorrsella* by having „rotaliid intraseptal passages" but no external sutural fissures. While the latter feature is confirmed by all previous authors and our own observations, the existence of intraseptal passages without openings to the exterior is highly improbable: Intraseptal passages are partially closed, interlocular spaces communicating always with the exterior. Our direct observations on the shell do not confirm the existence of intraseptal passages but the existence of a septal flap tightly glued to restricted parts of the septal face.

Plate 1 *Praestorrsella roestae* (VISSER). - Light microscope. Scale bar 0,5 mm valid for all specimens.

Fig. 1 Not quite centered axial section of large specimen. Alinya formation, Montsec, Southern Pyrenees, Spain; Late Campanian (see also CAUS et al. 1988).

Fig. 2-3 Sections more or less parallel to and at various distances from shell coiling axis. Betic Cordillieras, Maastrichtian (see AZÉMA et al. 1979, pl. 40).

Fig. 4 Section perpendicular to coiling axis, through dorsal part of shell. Vilavella fm., Sant Corneli Anticline, Tremp, Southern Pyrenees; Campanian (see GALLEMI et al. 1983).

Fig. 5 Section not quite perpendicular to coiling axis, centered. Note proloculus. Alinya E of Segre river, Serra de Turp, see CAUS et al. 1988; Late Campanian.

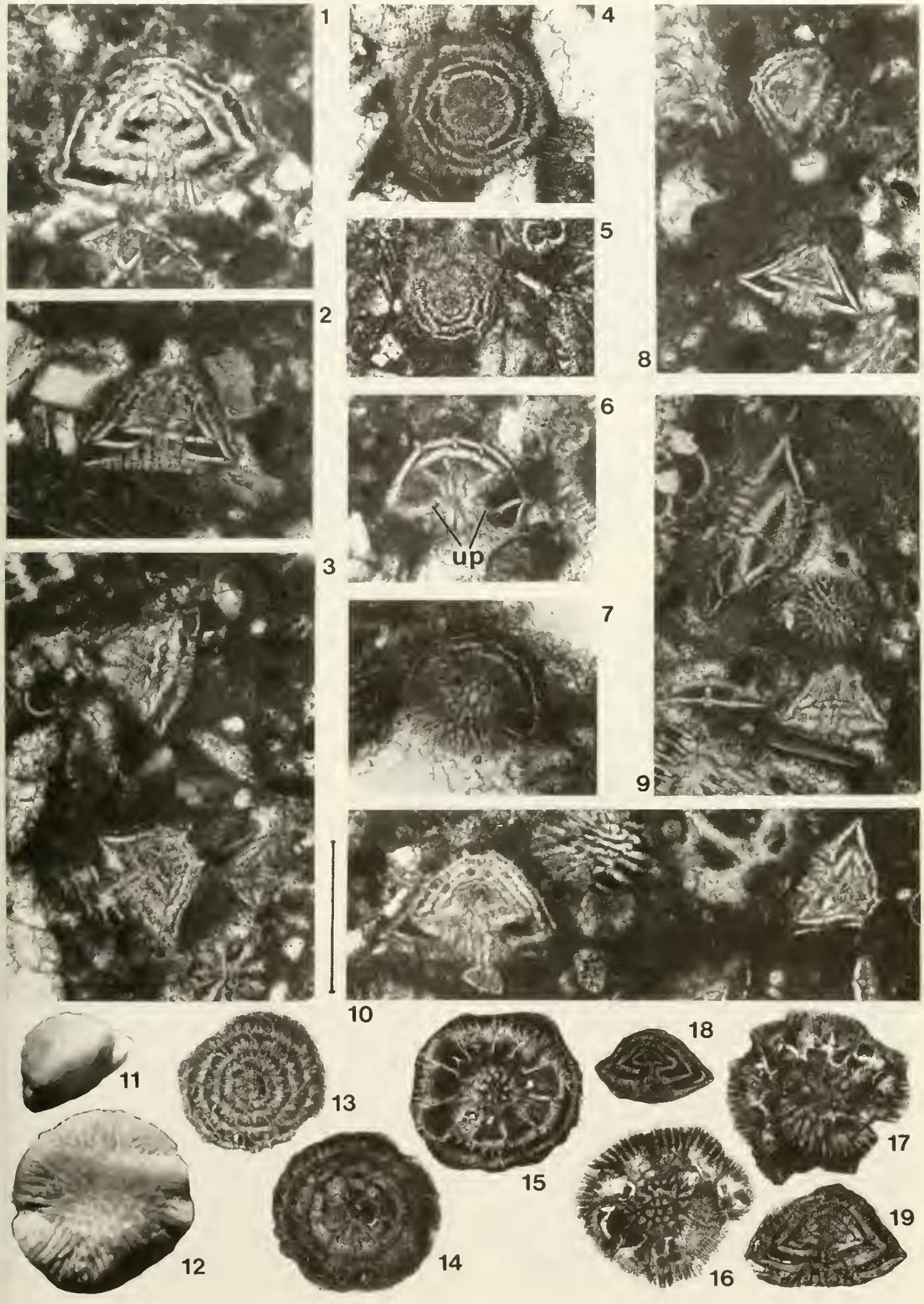
Fig. 6-7 Basal sections, slightly oblique; note umbilical plate (up) in 6. From Maestrichtian, Betic Cordillieras.

Fig. 8-10 Randomly oblique sections. Maestrichtian Betic Cordillieras.

Fig. 11-12 Lateral and basal views of isolated specimens; GOWDA's material from Vilagudi limestone, Ariyalur group, South India; Maestrichtian.

Fig. 13-17 Series of sections perpendicular to shell coiling axes, from 13 nearest to shell apex to 17 in shell basis. GOWDA's material.

Fig. 18-19 Subaxial sections, not quite centered; GOWDA's material.



HOTTINGER, L. & CAUS, E.: *Praestorrsella roestae* (VISSER) Plate 1

4. SYSTEMATIC POSITION OF *PRAESTORRSELLA*

By its modest size and its marginal, radial ornamentation of the ventral shell surface, *P. roestae* resembles a *Trocholina*. Although trocholinas have no septa, its umbilical architecture admits a canal system with simple, radial passages connecting the main lumen with a network of umbilical canals and a wreath of radial grooves not transformed into a cavity system by subsequent shell layers (HOTTINGER 1976). The question arises, if the ventral, marginal ornament common to trocholinids and *Praestorrsella* may reveal a phylogenetic link in particular between *Neotrocholina valdensis* REICHEL (1956), with a primary calcitic test, and *Praestorrsella*. On the other hand, similar radial, marginal ornamentation on ventral shell surfaces are known as true analogies in such unrelated forms as *Bolivinella*, *Annulopatellina*, *Angulodiscorbis* and *Glabatella* (see LOEBLICH & TAPPAN 1987). These ornaments are a functional feature indicating plastogamic reproduction cycles (see LOEBLICH & TAPPAN 1964 = gamontogamic cycle in LEE et al. 1991). However, *Praestorrsella* shells were never found in plastogamic position, ventral surface against ventral surface, as it is occasionally seen in residues containing *Bolivinella*, *Glabratella* or *Patellina*. Thus, we have to keep in mind the combination of an umbilical canal system linked by radial passages to the main tubular cavity of the shell with a ventral ornament indicating plastogamy as a feature common to *Trocholina* and *Praestorrsella*.

The presence of an umbilical plate in *Praestorrsella* may hint to a phylogenetic link with the group of Late Cretaceous to Paleogene rotaliids and in particular with *Storrsella* (DROOGER 1960). Although documented only by drawings, this genus doubtlessly possesses a well developed umbilical canal system, a single interiomarginal to marginal aperture, umbilical plates and dorsal alar chamber extensions. The existence of open intraseptal spaces is highly probable since the ventral sutures are deeply fissured and remain partially open.

Lockhartia (MULLER-MERZ 1980) is distinguished by foliar apertures present in *Praestorrsella* and missing in *Storrsella*. *Praestorrsella* cannot be a direct, Late Cretaceous predecessor of Paleocene lockhartias because large, complex, highly specialised rotaliids with similar structural features, „*Pseudorotalia*" *schaubi* HOTTINGER (1966), appear already in Early Santonian times. The same is true for *Rotalia* s. str. with *R. reicheli* HOTTINGER (1966) as an equally large and specialized species, while pararotalias (with a true toothplate; HOTTINGER et al. 1991) appear with *Praestorrsella* during the Campanian time interval.

There are two extant genera showing some remarkable similarities with *Praestorrsella*: *Discorbinoides* SAIDOVA, 1975 (type: *D. subpatelliformis* SAIDOVA, 1975) is characterized by an umbilical ornamentation with peripheral, radial grooves and umbilical piles (text fig. 2). The umbilical piles are produced by marked lamellar inflation of the imperforate foliar wall. When superposed in successive whorls, they form continuous piles similar to the ones in *Praestorrsella*. The umbilicus however is not entirely covered by fused folia. The dorsal side is evolute but covered with fine pustules obscuring the pattern produced by the chamber sutures. The latter are strongly inclined backwards, while the umbilical chamber sutures are radial, again as in *Praestorrsella*. A specimen with missing ventral chamber walls (probably resorbed during plastogamy) figured by HOTTINGER et al. 1993, pl. 148, fig. 5, shows septa disposed in radial direction below the ventral wall and forked towards the umbilical cavity. The fork indicates the double-walled nature of the septum and therefore the presence of a septal flap. There is obviously a shallow element closing off the main chamber lumen from the umbilical cavities and interpreted here as umbilical plate. In dorsal direction, above this element, a wide radial passage admits communication between main chamber lumen and the umbilical cavities. This internal architecture is almost identical with the one described here in *Praestorrsella roestae*.

Conorbella HOFKER, 1951 (type: *Discorbina pulvinata* BRADY, 1884) is less known as to its interior morphology. However, the umbilical ornamentation is identical and there are heavy dorsal pustules much like those of *Praestorrsella roestae*. In contrast to the latter, both extant genera mentioned here have evolute dorsal sides.

Plate 2 *Praestorrsella roestae* (VISSER). - Free specimens, topotypes from Maastricht (Limburg, Netherlands). SEM micrographs. Scale bar 0,1 mm.

Fig. 1 Dorsal view.

Fig. 2 Dorsal view of young specimen; note perforation in ultimate, slightly inflated chambers.

Fig. 3 Dorsal view of eroded specimen; Note septum (s) spiraling upwards towards shell apex.

Fig. 4 Oblique ventral view. Note peripheral radial ornament in penultimate shell whorl coalescing with dorsal-peripheral chamber wall in order to produce hemiseptula (hs). The ventral suture corresponding to the septum (s) can not be distinguished from other radial furrows.

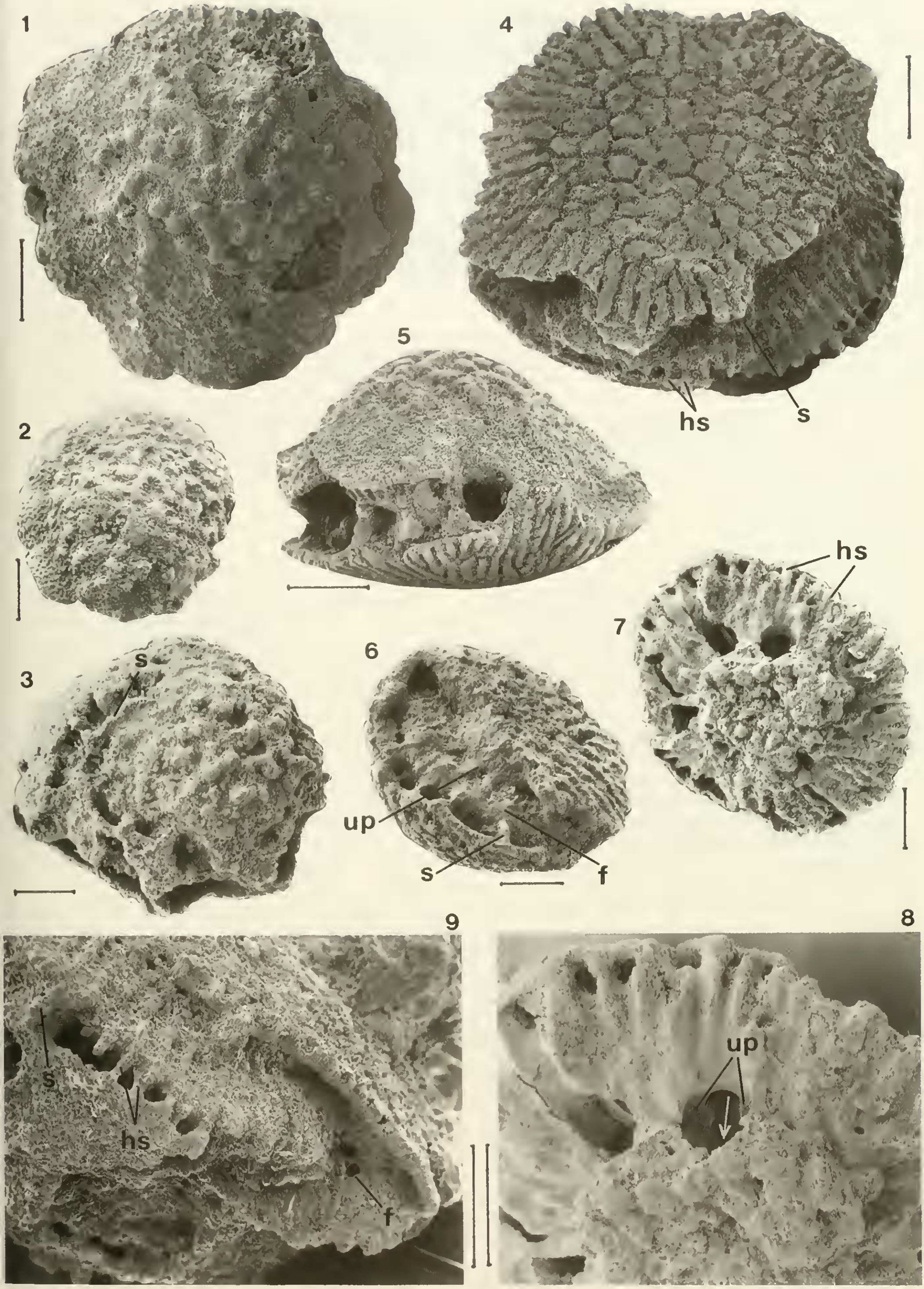
Fig. 5 Lateral view.

Fig. 6 Oblique ventral view, ultimate half whorl eroded. Note „empty" space over exposed previous whorl where the interiomarginal foramen (f) left no mark of the septum (s) while the umbilical plate (up) with its single, radial passage towards the umbilical cavities, closes off the chamber cavity.

Fig. 7 Oblique-ventral view of damaged specimen. All the ventral and peripheral chamber walls of the last whorl are broken away. Note hemiseptula at periphery.

Fig. 8 Detail of Fig. 7 showing umbilical plate (up) and radial passage (arrow) in chamber of penultimate shell whorl seen through a gap in the foliar wall belonging to this chamber and covering part of the umbilicus.

Fig. 9 Peripheral view showing foramen in interiomarginal position, partly obstructed by cement crystals coating the interior wall surfaces of all cavities in the shell. s: septum; hs: hemiseptulum.



HOTTINGER, L. & CAUS, E.: *Praestorrsella roestae* (VISSER)

Plate 2

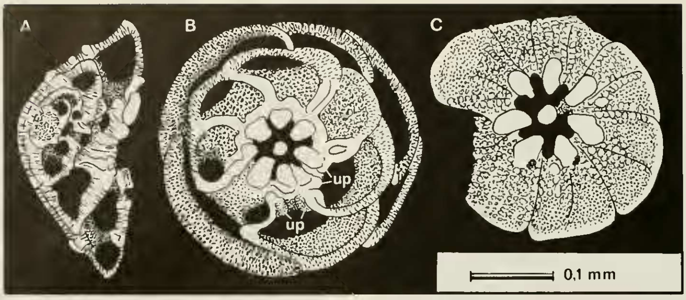


Fig. 2 A-C: *Discorbinoides* sp. - Gulf of Aqaba, off Marine Biological Laboratory, Elat, Red Sea; 150m depth. Camera lucida drawings.

A. Not quite centered axial section missing proloculus and central umbilical pile.

B. Section parallel to shell base. Note reclining septa in dorsal and radial septa in ventral part of the shell. Low umbilical plates (up) appear in section as „shoulders", the gap between them corresponds to the radial passages.

C. Section in a plane defined by the periphery of the last whorl. Dorsal part of shell removed, ventral part observed and drawn by transparency. Note large single piles crowning each folium. Radial passage by keeping open radial furrow between neighbouring piles when covered by subsequent whorl.

5. CONCLUSION

P. roestae, as described above, shows general similarities, namely 1. a trochospirally coiled, chambered shell of small size, 2. indications of plastogamic reproduction by its ventral, radial, ornamentational grooves independant of or in addition to sutural positions, 3. dense, heavy ornamentation on the dorsal side, exceptional for shells of such small size, and 4. the group of piles filling the narrow umbilical space, with representative genera of the family Glabratellidae. In addition, there is a striking similarity of the internal morphology of the shell between *P. roestae* and at least one species of *Discorbinoides*. Therefore, the genus *Praestorrsella* Gowda, 1978 is transferred here from the rotaliid subfamily Rotaliinae to the family Glabratellidae.

The difference in chamber arrangement on the dorsal side of the shell, involute in *Praestorrsella* and evolute in all other genera of the family Glabratellidae justifies the maintenance of the particular genus *Praestorrsella* with its type species *P. roestae*. Accordingly, the stratigraphic range of the family is extended by its first appearance already in the Late Cretaceous Campanian stage (compare Loeblich & Tappan 1987, Decrouez 1989). As to the history of plastogamic reproduction, *Praestorrsella* apparently narrows the time gap between possible Early Cretaceous trocholinid plastogamonts and the Early Tertiary ones.

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